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Teaching Entrepreneurship to Engineering Students

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Supplementing Engineering Education with Business Training

Andres C. Salazar
University of New Mexico

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Andres C. Salazar
Anderson Schools of Management;
School of Engineering;
University of New Mexico, Albuquerque, NM

Abstract

A typical engineering curriculum often leaves little time in a four-year program for a budding engineer to learn about the business aspects of the company he may join soon after graduation. The outcome of little business knowledge in the commercial application of technology by engineering graduates is a lack of understanding of the importance of their contribution to the company's bottom line. For those engineers who value business knowledge for their future profession, the alternatives for business training have been to take regular MBA courses when possible or settle for short certificate programs in a business school. In this paper we offer a list of business training topics that would prove useful for those engineers who wish to align their work in technology with the financial goals of a company in the commercial sector. Further, these topics would well serve those engineers who aspire to become managers and perhaps go on to found companies of their own. The importance of receiving business training early in their career may prove useful in accelerating their promotion to management levels or to greater success as an entrepreneur. Suggestions are made how an engineering curriculum can be structured to allow such business training topics to be covered for the benefit of all engineering students and then for those select few who wish to combine business with technology in their careers.

1.0 Why Do Engineers Need Business Training?

Graduates of engineering programs are trained in technology fundamentals and, soon after graduation, are expected to begin contributing towards the technology product and service development programs of the industrial and commercial sector. We will deal with the engineering career path of employment with a for-profit organization in this paper. The reason for this focus is simply that R&D spending today in the United States is predominantly by the industrial and commercial sector (see Figure 1).

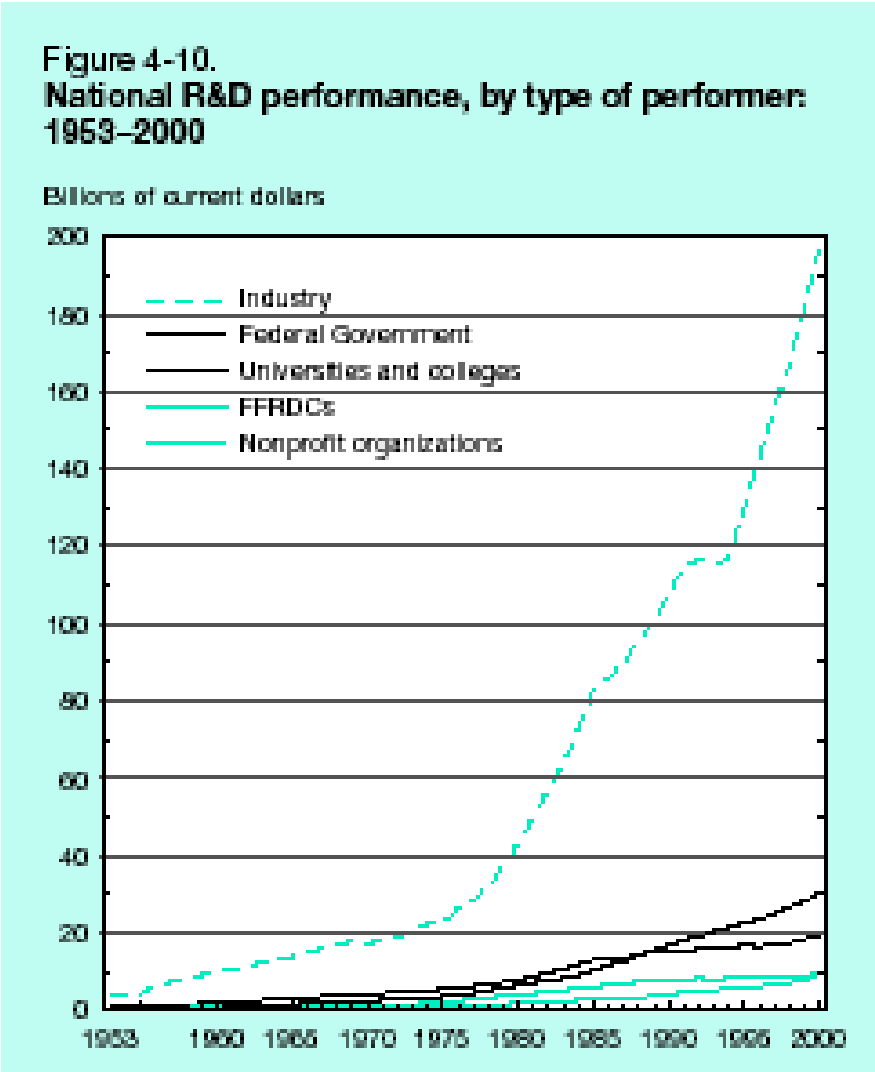

Figure 1.
(From National Science Foundation's Science and Engineering Indicators - 2002 [1])

The result of this disproportionate share of R&D spending is that most recent engineering graduates will be hired by the industrial and commercial sector. This means that the work recent engineering graduates will be engaged in will be funded by a "for profit" business plan. Such plans will emphasize efficiency and quality in reaching their profitability objectives. Engineers will be expected to participate in projects that deal with deadlines and budget guidelines and fulfilling customer requirements. At times they will be asked to participate in evaluating competitive products or services and in assisting sales and marketing campaigns. Although engineering curricula do prepare engineers to do well in understanding technology and contributing significantly towards a structured product development project where each engineer is told what to do, they are ill-prepared to deal with people management issues, budgetary and financial constraints and sales and marketing input into technology projects. The lack of such business knowledge can lead to frustration on the part of the engineer and can severely limit the engineer's contribution to the overall goals of the company he has joined.

2.0 Typical Engineering Curricula

A typical undergraduate engineering curriculum consists of coursework in the basic sciences such as chemistry, physics and mathematics, a few courses in the social sciences, fine arts and English composition and literature with the bulk of the courses, as much as 50% of the curriculum, concentrating in the major field of engineering with a few courses in the other engineering fields. The breadth and depth of the courses require discipline and dedication in study and performance. In fact, some engineering undergraduates find it difficult to complete the required engineering curriculum in four academic years for several reasons. It is generally conceded that the typical engineering curriculum requires the mastery of analytical skills and substantial study in various scientific fields. Also, students find it difficult to perform the "context switching" required in taking so many courses in different fields. Finally, universities find it necessary to modify the engineering curriculum due to so many advances in technology.

Although most engineering departments do a credible job in grounding the engineering students in the fundamentals of technology, they do not leave any time in the four year program to offer training in teamwork, creative problem solving, leadership and business principles.

3.0 Engineers as Managers

The vast investment being made in technology development by industry requires careful management if any efficiency in technology spending is to be realized. Companies find that the following traits in a candidate often lead to a successful manager:

(a) Knowledgeable in technology
(b) Trained in project management and risk assessment
(c) Excellent communications skills – oral and written

(d) Team building
(e) Objective in evaluation of people performance
(f) Aligns with company objectives – financial and time constraints
(g) Satisfies customer requirements
(h) Values quality and is efficiency conscious

4.0 Engineers as Entrepreneurs

Similar traits are found by investors to be desirable in entrepreneurs that have an engineering background. Although engineers have excellent technology training, the following attributes are sought by would be investors in evaluating whether the engineer-entrepreneur can really lead a start-up company.

(a) Committed to commercialization of technology discovery
(b) Willing to take reasonable risk
(c) Excellent communications skills
(d) Able to inspire others to take up cause
(e) Team building
(f) Authorship of sound business plan and subsequent execution
(g) Organizational recruiter and leader

In the commercialization process of a new technology, engineers are expected to take a lead role since they have profound knowledge surrounding the discovery. The underlying technology, in either material or process form, forms the foundation on which the company will be based. However, engineers fall short when they are called upon to develop the market potential of the discovery. Unless they have had business training, they can struggle to explain the strategy for best fulfilling the market potential of the discovery.

In particular, engineers have not been educated in marketing or sales, accounting or finance, and are not exposed to organizational management training.

5.0 Where Can Undergraduate Engineers Acquire Business Training?

It is often been said that students emulate their teachers. Engineering faculty are generally recognized for their research work. Tenure track programs at major universities require engineering faculty members to publish new findings in scholarly journals and trade conferences. Few universities acknowledge, much less reward, faculty members for any work that enhances their knowledge of engineering practices in industry and the commercial sector. Hence, engineering faculty members often have backgrounds long in publishing papers but short in practical engineering management in the commercial sector. Hence, engineering students cannot count on learning about business practices of technology companies from faculty members.

Should engineering students wish to take business courses while still undergraduates they find that rigorous engineering curricula leave little time for

taking such courses. Worse, engineering departments do not recognize the value of such business training.

Universities have yet to recognize the value of interdisciplinary degrees. Such degrees are often administered by the Provost Office and can become bureaucratic nightmares among the colleges that the constituent courses required for the degree. A new degree, of course, requires faculty approval and in the case of public colleges, approval from the Board of Regents or the state legislature.

6.0 What are the Appropriate Business Topics for Engineers?

Among the required courses in a typical engineering curriculum are (a) English Writing and Literature; (b) Economics; (c) Ethics; (d) Statistical Methods. These courses are often required courses in a business curriculum as well and the last three subjects are often taught in the business school itself. Other business courses that would enhance the business training of engineers include: (a) Accounting; (b) Finance; (c) Marketing; (d) Organizational Behavior; (d) Commercialization of Technology; (e) Strategy. The first two topics will enable the engineering graduate to understand the language of business – a balance sheet, an income statement and a cash flow statement. A marketing course will expose the engineer to the process of sales and customer relations, product distribution, pricing, branding, the product life cycle and the fundamental business proposition. A good organizational behavior course will impart the fundamentals of managing people and understanding the value of motivation and reward systems. Strategy lays the groundwork for dealing with competition and sustainable business advantage. Finally, commercialization of technology is a course that properly gives identity to the engineer in his/her major role – the creator of solutions to problems in society through technology. First, the course identifies improvement of business processes and the material needs of consumers, two major markets for innovative business plans. Innovation [2] follows the fulfillment of the improvement of business processes in the commercial sector or the satisfaction of consumer comfort or convenience.

7.0 Suggestions for Engineering Curriculum Changes

Engineering curricula do allow engineering students to take a number of social science, fine arts or language courses – about 15 semester hours. These courses are generally considered to be a "non-technical" minor track for enriching the educational experience of the engineer. An alternative track would be to allow the engineer to take the same number of hours in business courses. In this way, an engineering undergraduate would receive "non-technical" training but enables the business training that would prove useful in an engineering career in the commercial sector.

Some engineering schools have taken to teaching economics, ethics or other "business" oriented courses. This trend may lead to making these courses simply an

extension of more engineering courses rather than providing engineers the "non-technical" content that the same course could give if taught at the business school. Finally, one way to establish a cross disciplinary track for engineers who desire business training is to take advantage of a 3-2 dual degree format offered by some business schools. At the University of New Mexico, approval has been given by both the Anderson Schools of Management and the Electrical and Computer Engineering faculties to begin a 3-2 MBA program by which an engineer can receive both a BS in engineering and an MBA in five years.

References:

[1] National Science Foundation – Science and Engineering Indicators, 2002

[2] Jain, R.K., Triandis, H.C., Management of R&D Organizations, Managing the Unmanageable, John Wiley and Sons, 1990, Section 2.6 – The Innovation Process.